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The National Foundry College

It was not solely the war which caused the closing down of the British Foundry School, but dearth of students was also a factor. When a school or class is inaugurated, it takes up immediately all those students who have been waiting for such an event to happen. In subsequent years there is usually a falling-off in attendance until either equilibrium is established or the school or class is discontinued. It is because of this, and having a complete appreciation of the need for the continuance of what is now known as the National Foundry College, that we advocate the larger foundries to embark on a long-term programme for the periodic supply of students—say one or two each year, or, in some cases, every other year. It should be realised that firms which are members of employers' associations giving financial support to the scheme are entitled to have their fees remitted to the amount of the subscription paid by that association. The official wording is "at the discretion of the Board of Governors this fee (£60) will be remitted wholly or in part in the case of students nominated by firms belonging to associations or bodies contributing financially to the college."

A pleasing feature of the curriculum is that the early lectures are to be devoted to teaching the students just what the foundry is. We can assure our readers that there are very few young men in our industry who could name three foundries in Sheffield, Glasgow, Manchester, Tyneside, the Midlands and London and indicate their lines of manufactures. Nor could they give any rough statistical data as to the number of foundries in major divisions or the weight or value of their output. Next, the students will receive an insight into the actual operation of a foundry business to include siting, buying and selling, together with the intermediate factors. Then an appreciation is to be given of the "innards" of the raw materials used and how to control their use. The next logical step is how to process these raw materials so as economically to make castings. Having assimilated all the above severely practical information, attention is turned to chemistry, metallurgy, strength of materials, maintenance, engineering drawing and electrical engineering. Finally, the course terminates by covering those subjects which daily exercise the minds of the foundry manager and, on the more technical side, the chief metallurgist. Sandwiched in between the lectures are the laboratory courses, well covering the fundamental requirements of foundry technicians. We are full of admiration for the scope of the course, and have but one suggestion to make. We are well aware that the course is very comprehensive, but despite that, we still think some of the laboratory time should be devoted to X-ray examination to supplement the theoretical knowledge given.

The inauguration of the course is badly overdue, no doubt owing to wartime requisitions of college space, the non-availability of personnel, and the difficulty of marshalling all the essential backing. Now all is set fair for a start to be made in January, the only part now required is the recruitment of a class of suitable students, and this depends on the foresight of the foundry concerns. They will need executives in the future and no better preparation for such positions can be had than this well-designed course of study.

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The Building Exhibition

This is the first post-war exhibition of goods supplied to the building trades. It was opened last week at Olympia. Obviously there are hundreds of exhibits of the products of the foundry industry. One which interested our representative was an eggshell-blue bath and lavatory both of exactly the same tint, yet one was ceramic ware and the other vitreous enamelled cast iron; he recalled seeing the first experiments which have since been crowned with success. One bath shown was not of exhibition standard. Too many of the fires exhibited are carried out in a dirty brown; a wider and brighter range is overdue. One grate appealed to our representative on account of the fact that an excellent fire was produced from the lowest grade of gas-works coke. It was placed high in the recess and beneath it was a plated reflector made in rotatable sections for the easy disposal of ash into a removable tray.

In the field of taps for wash basins and baths, there is a strong tendency for these to be made as stampings or pressings instead of from castings. The use of the die casting for this line of business is not making the progress its potentialities warrant. Now that cast iron is being made in permanent moulds surely most of the non-ferrous alloys could be similarly manufactured.

Gutters and fall pipes were shown in a variety of materials ranging from the traditional cast iron to asbestos, light alloys and steel pressings. If the foundry industry would but vitreous enamel this class of goods they would have only price competition to meet.

Plastics were much in evidence, but they may still be regarded as providing custom rather than competition, though this condition may not be permanent. Our representative received several complaints of the inability of the foundry industry to supply cast iron "coppers," the traditional laundry equipment of the miners' cottages. There is still a large demand, and if they were made on mass production lines as are baths, a grievous shortage would be overcome. There is much useful gossip to be picked up at Olympia, and a visit by makers of builders' requirements is well worth while. The Exhibition closes on December 4.

An Invitation

For the first time since the war, ladies are being asked, by the London Branch of the Institute of British Foundrymen, to participate in a social function. Taking the form of a supper dance and cabaret, it is to be held at the Café Royal, on Wednesday, December 17. The President of the Institute (Mr. P. H. Wilson, O.B.E.), with Mrs. Wilson, and Mr. T. Makemson. M.B.E., the secretary, have accepted invitations. The dance band and cabaret are amongst the best London can provide. Provision has been made for 250 people, so that members from other branches and friends can participate. Tickets are 25s. each, and are obtainable from Mr. F. Arnold Wilson, of William Jacks & Company, Limited, Winchester House, Old Broad Street, London, E.C.2.

Forthcoming Events

(Secretaries are invited to send in notices of meetings, etc., for inclusion in this column.)

DECEMBER 2.

Institute of Metals.

Swansea Section:—Accounts of Visits to Canada and the United States under the auspices of the Nuffield Foundation Scheme, by Dr. H. Higgins, B.Sc., and Mr. D. W. Hopkins, B.Sc., at 6.30 p.m.. at the Y.M.C.A., Swansea.

DECEMBER 3.

Institute of British Foundrymen.

London Branch—East Anglian Section:—"The Metallurgist in the Foundry," by W. H. Salmon, at the Central Library, Ipswich, at 7.30 p.m.

The Institute of Metals.

DECEMBER 4.

Birmingham Section:—Students' Evening at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 6.30 p.m.

DECEMBER 5.

London Section:—Annual Dance at 4, Grosvenor Gardens, London, S.W.1, commencing 7.30 p.m.

Royal Statistical Society—Industria lApplications Section.

London Group:—Statistical Methods at the Mathematics Division of the National Physical Laboratory, principal speaker E. C. Fieller, at the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, at 6 p.m.

DECEMBER 6.

Institute of British Foundrymen.

Lancashire Branch:—Film and Commentary "The Production of Grey Iron Castings." Discussion led by C. R. Van der Ben and H. Haynes, at the Engineers' Club, Manchester, at 7 p.m.

Bristol ana West of England Branch:—"Stress Relief Heat-treatment," by A. B. Everest, Ph.D., B.Sc., at the Grand Hotel, Broad Street, Bristol, at 3 p.m.

Wales and Monmouth Branch:—"Production Problems in a Quantify Production Foundry," by J. Hird, at the Engineers' Institute, Cardiff, at 6.30 p.m.

Tariff Schedules

A White Paper giving a report on the Geneva Tariff negotiations and on the General Agreement on Tariffs and Trade is now issued. Copies of the Schedules giving details of the new tariff rates will be available for inspection at the Chambers of Commerce located at London, Glasgow, Birmingham, Manchester, Bradford, Bristol, Cardiff, Derby, Huddersfield, Hull, Leeds, Leicester, Lincoln, Liverpool, Luton, Newcastle-on-Tyne, Middlesbrough, Northampton, Norwich, Nottingham, Oldham, Portsmouth, Preston, Sheffield, Southampton, Stockport, Stoke-on-Trent, Swansea, Walsall, Wolverhampton, Aberdeen, Dundee, Edinburgh, Belfast, and also at the following regional offices of the Federation of British Industries:—Newcastle-on-Tyne, Leeds, Bradford, Sheffield, Nottingham, Leicester, Cambridge, London, Reading, Bristol, Birmingham, Manchester, Liverpool, Glasgow.

VICTOR MOYLE, AND COMPANY, of 38, Park Road, Hampton Wick, near Kingston-on-Thames, celebrates on December 1 its majority. Established in 1926 in a small rented workshop, the firm now employs nearly fifty people in its own well-built freehold premises. Mr. Clifford E. Moyle, B.Sc., is to be admitted to partnership on his coming-of-age, which coincides with the majority day of the firm.

Ferrous Die Castings*

The Continuous Production Process

By C. D. Pollard, H. A. Redshaw, and C. A. Payne

(*Concluded from page* 245.)

Plant Layout and Organisation

The melting unit, the layout of which is shown in Fig. 23, consists of five 42 in. dia. cupolas in a line at one end of the shop, metal being tapped from these, by means of a syphon brick, into 5 cwt. bull ladles, suspended from a monorail (Fig. 24). Nine production machines extend in two rows from the cupolas, the monorail for the supply of iron to the machines passing between the two rows and returning along the wall of the shop. Two men are responsible for the delivery of the metal, six or seven ladles being in use at one time. The machines are arranged with the pouring stations adjacent to the monorail, thus giving only five stopping points for metal transfer in the system. The pour-down is accommodated in cast-iron pig moulds on trunnions in a frame at the point where the return line turns towards the cupola spouts.

The transfer of metal from the bull-ladle to the hand-ladle is achieved without stopping the machine, the casting ladle being simply swung back whilst being filled (Fig. 25). As it is the essence of the use of tea-pot ladles not to drain them through the spout, these hand-ladles are rarely emptied during the casting operation, being not so much refilled as continually "topped-up" from the bull-ladle. Casting is continuous, the hand ladle being swung over the dies and moved in time with them (Fig. 26).

As the castings solidify, the dies are opened, the castings are hooked out (Fig. 27), and the hot castings and sprues put into steel containers, arranged behind and to one side of the operator. When filled, the containers are moved by means of a Tow-motor (Fig. 28) to a storage area, where the castings are left to cool. The cooled work is sorted, non-cored work going direct to the heat treatment furnace. Cored work is taken to be shot-blasted for the complete removal of adherent sand prior to heat-treatment. Sprues and obvious waste castings are returned to the cupola stage. After heat treatment all castings are shot-blasted, ground, fettled and inspected in the normal way, prior to going to the despatch warehouse.

Quantity Control Inspection

Every hour, a complete set of castings is taken off every die in production and carefully inspected. Any defects are noted on a suitable form and then reported to the shop foreman, so that the appropriate action can be taken immediately to correct the defects. Not all defects can be seen from a purely visual examination of the surface, so machining tests are carried out as well as fracturing of the castings, for evidence of sub-surface defects. When it is realised that between 5,000 and 6,000 castings is the average hourly output from this plant, the paramount importance of such a procedure becomes very evident.

The three main factors entering into the rapid shop control of defects are metal condition (as indicated by appearance and pyrometer readings), pouring technique, and mould condition (including cores). Metal conditions, arising out of normal cupola operation, can

*Paper presented at the Annual Conference of the Institute of British Foundrymen held in Nottingham in June, 1947.

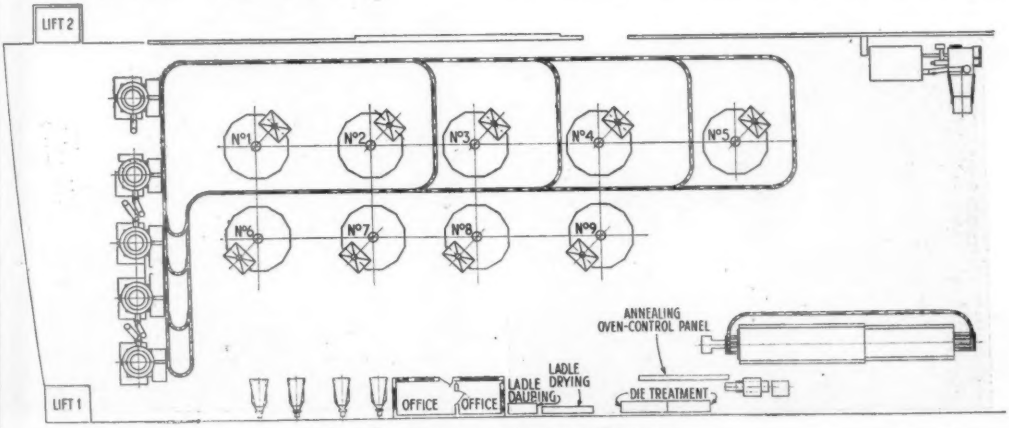

FIG. 23.—LAYOUT OF DIECAST FOUNDRY.

Ferrous Die Castings

generally be checked by use of the optical pyrometer, core condition is largely a function of inspection, whilst die condition may require no more than a missing of one cycle to allow of touching up, or may call for immediate die removal and replacement. In the former case, the operator will not pour that particular job, in the second case, the machine will be stopped whilst the change is made, a delay of some 5 to 7 minutes.

Die Life

The life of a die is governed by the type and weight of the castings being made, the design and layout (*i.e.*, metal distribution in the mould cavities and the wall thicknesses thereabout) as well as the material from which the die is made. To a greater or lesser degree, every die is subject to thermal shock, in being heated and cooled repeatedly over a small area of the face, whilst the back of the die is being positively cooled by air-flow. Such repeated heating and cooling induces cyclic stresses of a variable magnitude, so that such conditions may be truly described as thermal fatigue.

The main factors contributing to thermal fatigue failures, are stresses set up by constantly reversing local expansions and contractions, aggravated in cases where phase changes result in additional volume alterations, and growth of the mould surface. Projections on the mould surface forming deep pockets in the castings and conversely pockets in the mould for bosses and projections on the castings, and cavities of a low surface area to volume ratio, are the most severe problems to be faced. Some counterbalancing of thick and thin sections can be achieved by variations in die thickness. Heat is removed from the casting by conduction through the die body and thence by radiation and mechanical transference to the cooling air stream. The rate of heat flow is more rapid through the metal section than across the metal-air interface. Thus, thin

FIG. 24.—TAPPING METAL INTO BULL-LADLE.

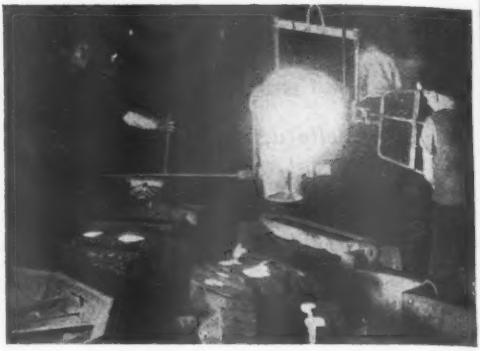

FIG. 25.—TRANSFER TO HAND-LADLE.

walled moulds heat up more rapidly than thick walled sections due to this, as well as to their lower thermal capacity resulting from the lower bulk.

The ideal die material will, therefore, be one of good thermal conductivity, minimum thermal expansion characteristics, with phase changes occurring at temperatures above the highest likely to be attained in service, and freedom from scaling or growth. Furthermore, it must be readily castable into variable

FIG. 26.—POURING THE DIES.

sections, with an absence of internal defects or segregation and must be readily machineable. Above all, it must be available at a price that does not render its use uneconomical, except for very large quantities. In short, the demands are such that very few materials, other than cast iron, are capable of meeting them.

Metallurgical Control

The routine control of metallurgical quality is based on the casting of standard test bars in a special die regularly throughout the day. The die is warmed up (on a single unit) by casting two sets of bars which are discarded, and is then maintained at a predetermined temperature (between 150 and 250 deg. C according to the predominant class of work in the shop) by means of a gas jet. The temperature is checked by a thermocouple inserted into the body of the die.

Two test bars are cast at a time as shown in Fig. 29, one being $\frac{7}{8}$ in. dia. by 8 in. long and the other has a $\frac{1}{2}$ in. dia. by $2\frac{1}{2}$ in. gauge length and $\frac{7}{8}$ in. dia. ends. Within half an hour of pouring, the test bars are collected, the $\frac{7}{8}$ in. plain bar brinelled and drilled for analysis, the end being broken off to give a guide to the fracture. After stamping with the appropriate date and time, they are sent for heat-treatment. Following this, they are shot-blasted, the $\frac{1}{2}$ in. dia. or "black" bar is pulled in the tensile machine without further treatment, the $\frac{1}{2}$ in. dia. bar being machined to the standard 0.564 in. dia. before testing. Both bars are brinelled, after tensile testing, as a check on the heat-treatment.

The test results are governed more by physical than chemical variations, such factors as melting temperatures and conditions, pouring and die conditions, and even the fractures of the pig irons used in the charge have a more directly observable influence than day to day variations in chemical composition. This composition is maintained slightly on the hyper-eutectic side (as indicated by the sum of TC + ¼ [Si + P] being above 4.3). The total carbon range is 3.4 to 3.65; the silicon 2.5 to 2.7; the manganese is approximately 0.7 per cent.; the phosphorus average is 0.55 per cent., whilst the sulphur is held at 0.1 per cent. maximum.

FIG. 27.—CASTING REMOVAL.

FIG. 28.—TOW-MOTOR REMOVING CASTINGS IN CONTAINER.

Microstructure

The influence of the undercooling is to suppress the formation of primary graphite, the first constituent to

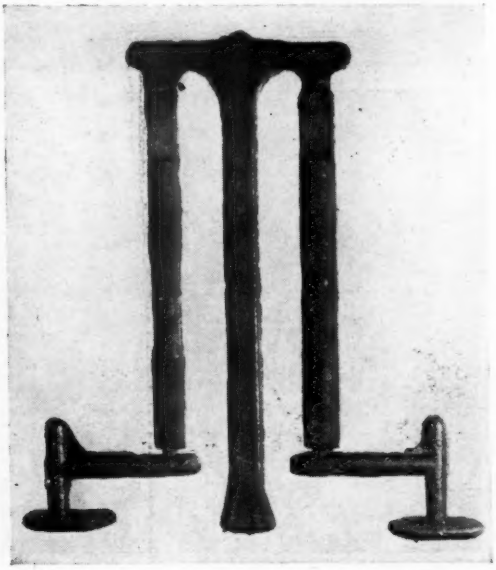

FIG. 29.—SET OF DIECAST TEST BARS.

D

Ferrous Die Castings

solidify being the finely divided austenite from the supersaturated solution. The graphite is in the typical hypertectic form of very fine flakes in aggregates, or outlining the primary dendrites as a result of the decomposition of carbide and diffusion of carbon to the edges of the dendrites. The "grain size" of the residual ferrite matrix is exceedingly fine, and as this matrix contains some 2½ per cent. of silicon in solution, together with a fair proportion of the manganese, its physical and mechanical properties is modified acordingly. Photomicrographs (Figs. 30 and 31) indicate the structures obtained before and after heat treatment.

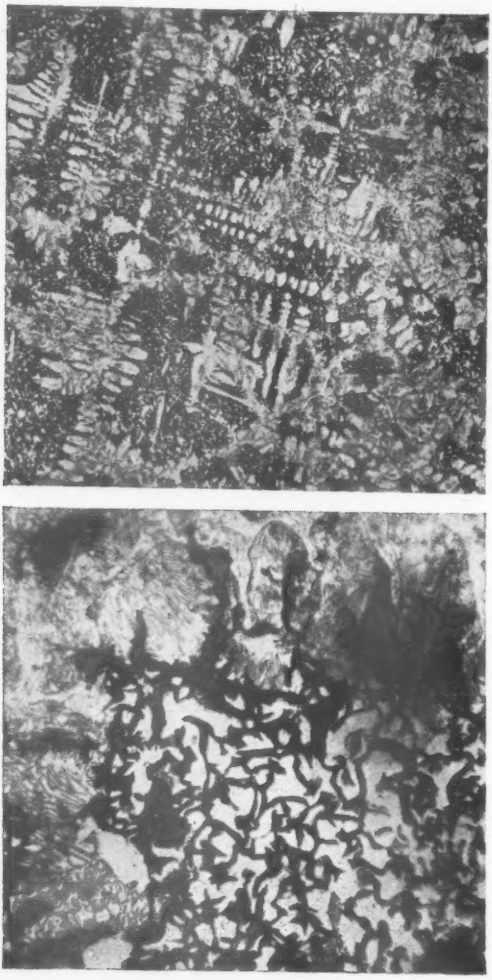

FIG. 30.—MICROSTRUCTURES, AS CAST.

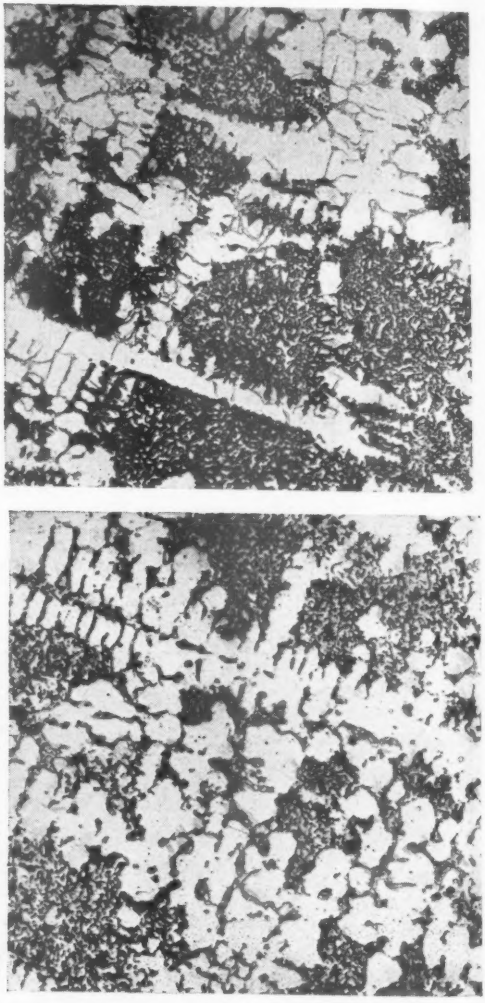

FIG. 31.—MICROSTRUCTURES HEAT-TREATED.

General Survey of Properties

The tensile strengths obtained from the routine test-bars are of the order of 17 to 20 tons per sq. in. from the "black" bar and 14 to 17 tons per sq. in. from the 0.564-in. dia. machined bar. This difference between the two types of test-piece is due not only to the difference in section, but also to the fact that, in the latter case, the casting surface is removed to a depth of approximately $\frac{2}{16}$ in. The Brinell hardness is also to some lesser extent affected by section thickness, the most interesting feature being, however, the remarkable uniformity in hardness over heavy sections.

The approximate relationship between these two properties and the section thickness is shown in Fig. 32, the data for which have been obtained over a long period of time from typical production castings. As some of the castings concerned are cored, it is to be expected that there will be a widening of the range of tensile strengths, due to the restraining influence of any cores on the undercooling of the sections adjacent to such cores.

Other properties have been studied in some detail, although not on the basis of routine control. These include transverse compression and impact strengths. On the standard $\frac{1}{2}$-in. dia. by 13-in. long bar tested on 12-in. centres, the transverse modulus of rupture is 38 to 42 tons per sq. in. with deflections of the order of 0.2 to 0.3 in. with low-phosphorus contents. In compression, considerable deformation occurs prior to fracture. An interesting example of this, together with typical load-deformation and stress-strain curves, is shown in Fig. 33. In this particular series of tests, the load was applied in $\frac{1}{2}$-ton intervals, left until a steady

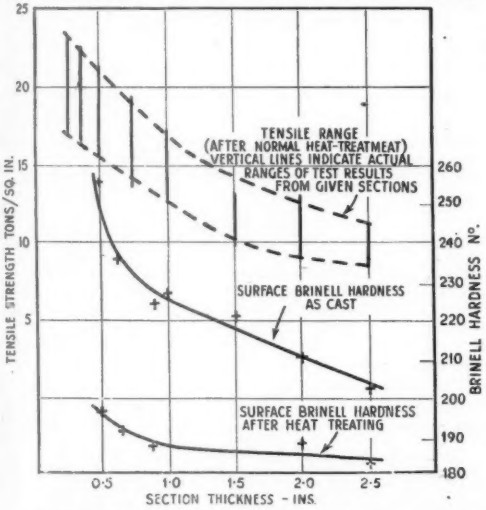

FIG. 32.—RELATIONSHIP OF BRINELL HARDNESS AND TENSILE STRENGTH WITH SECTIONAL THICKNESS.

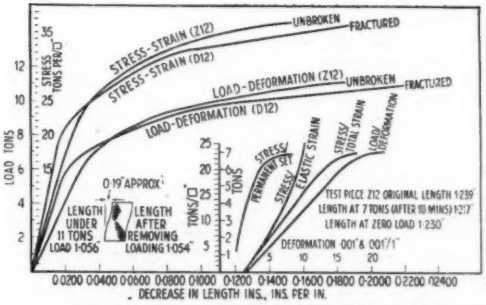

FIG. 33.—COMPRESSION TEST RESULTS.

reading of deformation was obtained, then removed, and again the steady reading of the "recovered length" taken. The lower platen on the testing machine was free to move sideways with the results shown. As an inset to this illustration, the load deformation, stress-strain, elastic and permanent deformation, obtained on this test-piece are given up to 7 tons load. The impact test-results range from 15 to 20 ft.-lbs., using the British standard bar of 0.798 in. dia.

In connection with previous remarks concerning the less marked influence of chemical composition, experiments, with ladle additions of phosphorus, have indicated that, with other factors reasonably constant, a measurable effect can be determined. The results in graphical form are given in Fig. 34 with respect to Brinell hardness, impact strength, tensile and transverse strengths. This element exerts its influence due to its lowering of the solidus temperature with a tendency to the lessening of the undercooling, and secondly, due to the formation of increasing amounts of the hard phosphide constituent, ultimately resulting in a continuous, cellular net work.

Service Properties

There are certain properties which are not or cannot be readily measured in normal routine testing and inspection, but are of vital importance in ensuring satisfactory performance of the castings. Typical among these service properties are complete freedom from porosity, free machinability and wear resistance, naming but a few.

Castings requiring complete soundness are such as refrigerator valve plates used at pressures up to 180 lb. per sq. in., using ammonia or "freon" (nitro-difluoromethane); hydraulic brake and shock absorber cylinders tested up to 1,800 lb. per sq. in. hydraulic pressure, and in contrast, shot castings where uniform density is a factor in their ballistic performance. All the above examples, ranging from simple solid masses to light and heavy sections in close juxtaposition, present considerable and recurrent difficulties in conventional mould materials. Total customer rejects of 0.2 per cent. of castings supplied, covering all causes of rejection, have effectively established the claims of this process.

Ferrous Die Castings

The machinability of castings is a factor most readily defined, not by measurements on a given casting, but by tool life in terms of the length of time and either the number of pieces or amount of metal removed per regrind of the tool. Given identical operations on similar shapes and positions with castings made in sand moulds as against these from the Eaton Erb process, increases up to 25 per cent. in machining speeds have been achieved without, in any way, sacrificing other considerations. Another point of interest in this connection, is that a great number of castings are being supplied to customers who have their own foundries. Despite the fact that the customers' own output is also annealed for machineability, the diecastings can more than hold their own in this respect.

Wear can best be defined as the removal of material when the wearing part is in contact with a surface or surfaces in motion relative to that part. The factors involved are generally friction and pressure, modified by lubrication conditions and temperature variations, as well as by the continuity and direction of the relative motions. The fine-grained silico-ferrite matrix containing evenly distributed, finely divided graphite and steadite, does form an excellent bearing material. The uniformity of structure and absolute soundness over any given section also eliminate localised breakdowns, which are frequently the cause of premature failure. With normal lubrication, under sliding friction (valve guides), continuous rotary motion (connecting rods for refrigerators) intermittent sliding contact (as with gear teeth) the diecast material normally outlasts sand castings from a wear point of view. Dry frictional wear and abrasion cannot be generalised any more than can corrosion applications. Each case has to be decided upon the conditions and circumstances peculiar to that application.

Fig. 35 indicates the range of castings produced by this process, each group of castings shown requiring predominantly one or other of the three service properties outlined above.

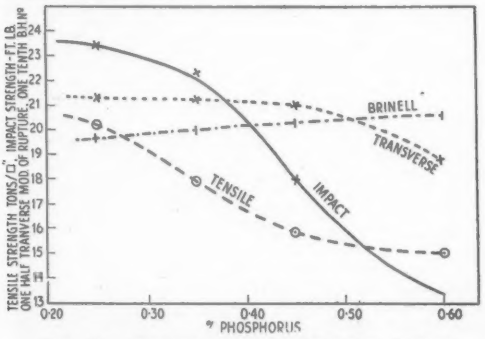

FIG. 34.—INFLUENCE OF PHOSPHORUS LADLE ADDITIONS ON MECHANICAL PROPERTIES.

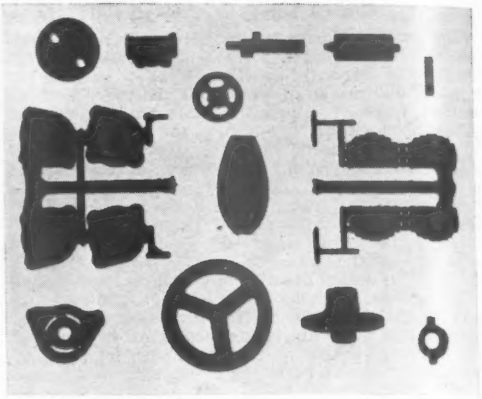

FIG. 35.—TYPICAL FERROUS DIECASTINGS WITH COMPLETE SPRAYS AS REMOVED FROM THE MOULD.

This Paper has outlined the knowledge and technique accumulated after close on 6 years application of the Eaton Erb process. It is a record of achievement of no mean order, but is certainly not the end of the story. New developments in the direction of fresh industrial applications, of greater complexity in designs and of improved manufacturing technique, are already visible in the current production programme. The continued investigation and experimental work, carried out in both foundry and laboratories, are adding to the understanding of the metallurgical features and undoubtedly will assist in this future progress.

In conclusion, it remains but to give the Authors' grateful acknowledgments of the permission and encouragement to publish this Paper received from the directors of Messrs. Qualcast, Limited, which firm holds the sole rights for the Eaton Erb machine and process for the United Kingdom and the whole of Europe.

DISCUSSION

Congratulating the Authors on their Paper, the CHAIRMAN (Mr. R. B. Templeton) thought they were all indebted for the contribution made by Mr. Payne, and he considered the consummation of the Paper would be their visit to see the plant in operation. Obviously, under this system, there was no scrap as a result of sand, but he wondered if they had anything in place of sand troubles. Also, did the Authors maintain that the dimensional tolerance by their process was closer than could be obtained by a machine-moulded sand casting?

Scrap Losses

MR. REDSHAW, in reply, said they did get about 5 to 6 per cent. scrap, which included working up the dies in the morning from cold. The defects they had were mainly as a result of cold iron; and they might have a

few gas or air holes, but they were totally different from any defects which one experienced in a sand foundry. Regarding the dimensional tolerance, up to now they had made no claim regarding their system over sand castings. They should be more accurate than sand castings, except probably there was some variation across the die joint. It must always be borne in mind they were pouring molten iron on to the face of the die, and the face of that die expanded, whereas the back of the die was still cool, so some distortion resulted there, usually about 0.020 in., which he considered was comparable with ordinary sand-casting. Apart from the dimensions across the joint, the castings were produced as accurately as the die was machined.

Early Experiments

MR. T. R. TWIGGER said that some years ago the company with which he was associated had the opportunity of taking up the process described by the Authors, and they had a single unit machine which was used on an experimental basis. For various reasons, among which was the impossibility of expanding in their locality under wartime conditions, they had to forgo that opportunity, but he was very glad indeed to have the chance of congratulating the Qualcast Company on the success they had achieved. He personally had no doubt that the process was very suitable for the quantity production of many types of small castings, and there must be many applications which could usefully be tackled.

He was, however, rather diffident about using the process for parts that had to stand up to any high degree of abrasive wear, as the structure achieved did not seem to be particularly suitable. There were two troubles which they themselves had encountered. One was the difficulty with flash. It always seemed difficult to close the mould perfectly; thus there was always the liability of a certain amount of flash at the joints. That, he thought, was one of the reasons why annealing of the casting was necessary, and he would like to know whether flash could not be eliminated or at least greatly reduced. The other point was that he had believed it had always been the intention of the originators of the process to build up the mould with a substantial layer of refractory material such as would either eliminate or greatly minimise chill. He thought the logical step would be to do that entirely by using a mould material having a lower conductivity than the thinly-coated cast-iron moulds. He asked if any advances in that direction had been made, because it seemed that if the danger of chill could be eliminated on the flash or on other thin sections, they might avoid the under-cooled graphite on the outside of the casting, which might in some cases be an undesirable feature, and they might possibly also avoid the annealing operation.

Wear Resistance

MR. PAYNE, dealing with the resistance to abrasive wear, said they had not regarded that as being a general virtue of cast iron, for abrasion, like corrosion, needed to be considered upon the merits of each particular application. With regard to wear of the lubricated parts, it had been their experience that this material would outlast the normal sand-cast material. But they had to bear in mind they were not dealing with just ordinary ferrite, but with silico-ferrite with an extremely fine grain, so that after heat-treatment their figures were still in the region of 190 Brinell, with no signs of pearlite except possibly round the edges of the phosphide, with the phosphorus between 0.3 and 0.6 per cent. This they had come to regard in certain applications as being almost the ideal bearing material; with the micro-constituents evenly distributed throughout a fairly tough matrix. Then they had the graphite (which, they were all agreed, was an excellent lubricant), not in loose pockets but evenly dispersed throughout the whole matrix. On that basis, which was as far as they had gone at the moment, the material wore very well.

A point Mr. Payne desired to make was that one of the difficulties with an insulating mould material was getting the heat away from the right spot. Here was a process where they could get the heat away from the whole job, and if they applied their insulating material locally, they then had a possible means of slowing up the cooling rate of a localised section, but how that worked out in practice, Mr. Redshaw could tell better than he.

Increased Fluidity

MR. REDSHAW thought he would be correct in thinking the question of flash was in regard to valve stems. On valve stems, it was undoubtedly a nuisance. An outstanding feature was that the metal was much more fluid in a die than in a sand mould, with the result that there was a tendency to get flash on any castings. In other words, iron would always run into the joint of a die. Some of the flash on the castings was found to be just like tissue paper and could be broken off with the fingers, so it did not give them any trouble. They put the castings through a tumbling barrel which cleaned the castings and removed the flash at the same time.

Mould Face Distortion

MR. BROWN said he, too, had been one of those who with Mr. Twigger many years ago tried to develop a similar idea of using a permanent mould. This happened about 1918, but he had realised now from what he had heard and seen that they had tried to do too much. The castings they experimented on were heater pipes with fins, so members would have some idea what it had meant. They had started with a die about 18 in. by about 9 in., and he asked them to imagine what a task it had meant with a die of that size and shape. He was in agreement with Mr. Twigger's experiences regarding the distortion. He remembered they had suffered two very serious defects. One was the distortion of the face of the mould, which they could only experiment with slowly, as it cost much money and time to make a new one.

There was another aspect for him which the Paper had thrown light on. He was rather alarmed at 5 to 6 per cent. scrap, but if they warmed the dies up, which he presumed they did, by pouring metal in, he could imagine they would get a lot of short-run castings, and the scrap would naturally rise.

Ferrous Die Castings—Discussion

A Pioneer Effort

MR. REDSHAW said he wished to stress that they had actually spent nine months' work on the plant before they had produced one good casting. That would perhaps explain why they had gone so far, but there was still much to be done. He confessed he was very proud of the figure of 5 per cent. scrap, and that he operated the shop with 94 to 95 per cent. efficiency every day.

As to the composition of the materials used in the dies, MR. PAYNE said that to give the compositions so far used would require a separate Paper. From their experience, the ideal die material was one having a good thermal conductivity; minimum thermal expansion with phase changes occurring above the temperatures which the dies were likely to attain in service; freedom from strain; being readily castable into awkward sections; readily machinable; and, above all, it must be available at an economic price. All he could say was that cast iron was the only material to do all that, and which cast iron was the best depended entirely on the casting they were going to make in that die. Metallurgists were still looking for the answer for the best ingot mould, and had been for years before the Authors were making dies. They themselves were still working on the problem of what was the best all-round material for making dies.

Experimental Results

MR. J. BLAKISTON said he also had been interested in the production of castings from permanent moulds, and a degree of success had been achieved from the initial experiments which had exceeded expectations. There were one or two problems, however, which had caused concern, and he would describe briefly the experimental plant so that the Authors might be able to enlighten him from their own experience.

A circular table was mounted on ball-bearings so that it could be readily spun by hand. On this table were mounted twelve moulding units; these mould units were composed of two cast-iron blocks with bottom hinges loosely pinned, the pins having approximately $\frac{1}{4}$-in. play. Exact location was obtained by obtuse angled dowels. The dies were not machined on the surface exposed to molten metal, as it was believed that a longer life was so achieved in conjunction with the coatings used. However, the contact faces were flat machined, the dies being lined up for correct dowelling by dropping a sample casting between them, which also indicated when the correct depth of machining had been carried out. The coating was merely a chill blacking comprised of carbon bonded with colloidal clay. Several thousand castings of quite a heavy section, namely, 3 in. dia., had been produced from each die with no appreciable wear. The dies were made from the same metal as the castings and contained 0.9 per cent. phosphorus and 2.75 per cent. silicon. Although the process was successful, it was noticed that a considerable expansion occurred at the solidification point of the metal, which forced the dies apart. This expansion destroyed or distorted the first experimental dies, which were made with accurately fitted hinges. Eventually the trouble was overcome by adapting loose pin hinges, and utilising heavy spring clamps which allowed expansion to take place without damage to the mould. When cored castings were being manufactured, there was always a fear of a serious explosion on account of the core breaking and floating up to the top runner, hermetically sealing the mould. To guard against this, the heaviest portion of the casting was always placed at the top of the mould, and the runner was placed over this section of such a size to render this portion of the casting the last to solidify.

Could the Authors give their opinion as to their experience of the expansion described and also as to the explosion danger?

Mould Distortion

MR. REDSHAW agreed they had experienced similar difficulties with regard to distortion. They had tried in the early days holding the dies together by using heavy bolts in the corner, but had not been so fortunate as Mr. Blakiston. They had found they could not prevent the distortion, but they had also found that they were worrying over a trifle. The explanation was that the die face got hotter and hotter, while the back of the die remained cool, and this caused the distortion, although in their experience its effect was not dangerous.

Regarding explosions due to the use of cores in the die, he had never had any troubles with those, but they had always hung their cores from the top of the die.

MR. BLAKISTON said he had previously expected the cores always at the bottom of the die.

MR. REDSHAW said they had had a job some time ago of a small core being inserted in the die face, and that had failed, but it was the only time, and had been due to carelessness, as no vent had been incorporated.

On the question of die surface, Mr. Redshaw said they had been of a similar opinion as Mr. Blakiston at one time, but were not now. They had got no benefit from cast surface dies as against a machined surface, and they had reached that conclusion after making many thousands of castings.

Delayed Application

MR. D. SHARPE said it was over 20 years ago since he had come in touch with this particular process in the States, and he had brought it over to this country. His reason for speaking was to try and bring home to the people present that it was worth while examining every proposition that was put before them. There was no doubt that 20 years ago very successful castings were being made in America, and later they were being made in this country in a very small way, but there were very few opportunities for using such an apparatus here, and it was not until Qualcast had adopted it on war work that an opportunity had come forward to put such a mass-producing machine on the market. His experience, when he had pressed the question with various people who could have used it, was that they were nervous about it. They would not quite believe the specimen castings that he had brought from America had

been made without any sand moulding and had been made as chilled castings. The business had then been in its infancy and suffered very much from the buckling of the dies, which either spread on the top and bottom or buckled in the centre. The apparatus as it was now developed, of course, was the outcome of 20 years' work, and he gathered from what he had read, the Authors had overcome successfully many of the difficulties that were experienced 18 to 20 years ago.

Effect of Hot Dies

MR. B. HIRD said he, in 1909 or 1910, had been inspired by the possibilities of permanent iron moulds by a series of articles in "The Foundry" by Edgar Alan Custer. Mr. Custer had done much experimental work with iron moulds and finally established a special foundry for making cast-iron soil pipes, including bends and tees in iron moulds. Mr. Hird at that time was connected with Bentalls, of Heybridge, Essex, where they had experimented with, and made, a number of castings in iron moulds, the most successful being chaff-cutter weights and feet cast on steel legs; about 30 cwts. of weights were cast with the first metal on Monday mornings, but the legs were cast continuously each day. Most of the other jobs made in iron moulds proved to be too expensive, due to the short life of the moulds. In conclusion he had one question to ask, did the Authors get waste and have to stop when their moulds became too hot?

Mould Life

MR. A. S. WORCESTER asked what was the capacity of the machine as far as size of casting was concerned, and also the average life of the moulds or dies.

In reply, MR. REDSHAW said the heaviest casting which they produced weighed 35 lbs. and was about 24 in. long. It was a solid weight. The life of the mould was a question asked by everybody, and it was impossible to answer unless the type of job was specified. If Mr. Worcester had any particular job in mind, he could then perhaps estimate it for him.

On being asked for the lightest and heaviest jobs they did, Mr. Redshaw quoted a job with which they were probably all familiar, the 3-in. mortar which was made during the war. Out of those moulds they had 36,000 pours, which was 72,000 castings off one mould.

MR. J. ROXBURGH said he had been very interested in the statement made by the Authors that they could guarantee the soundness of the castings. In another statement, they dealt with thick and thin sections in a casting, and said some counterbalancing of thick and thin sections could be achieved by variations in the die thickness. Could the Authors give some information regarding the section of the chill in relation to some particular section of the metal in contact with the chill and how they varied that section of chill to counterbalance the effect of the thick and thin sections. He believed also Mr. Redshaw had dealt with the range of temperature of the dies, but at the same time he asked for the range of pouring temperatures which were used. Another point was the reference to the refractory coating of the die and the soot which was used each time to prevent instantaneous freezing. Could a little more information be given about the refractory and also the soot?

Soundness

Dealing with the soundness of castings, MR. PAYNE said he was able to give an assurance as they had sectioned many of the castings for confirmation. The type of casting mentioned was a solid 4-in. dia. practice shot, 10 in. long, and the surplus metal weighed exactly 2 lbs. In other words, there was no feeding, and one casting in every 500 had to be sectioned to establish that there was no unsoundness, but over the first 200,000 none was found. After that, they relaxed a little, and sectioned only one in every thousand. In smaller castings they were making quite a number for hydraulic brake systems and other similar high-pressure oil applications, but even with pressure testing, not one so far had been rejected. The explanation was that, when the castings solidified, freezing occurred very suddenly, and graphite in the centre occupied much more volume than the corresponding iron carbide on the edge. The resultant expansion was restricted and as a result it was their opinion there were no voids left in the material, a view that was confirmed by microscopic inspection.

MR. REDSHAW said, strangely enough, they did not vary their die section very much. The variations of castings sections gave nothing like the trouble one might expect. There were times, however, when variations had to be made. One was, if they made a very heavy casting, and they would then thicken their die section up to probably 2 in. or 2¼ in. Apart from that, the die section was usually about 1¼ or 1½ in. thick. Other times, when they got very light castings, they put cooling pins on the back of the dies, and it was a simple matter if the die was not running hot enough on the machine, to simply knock-off those pins or, in other words, cut out the cooling system. All the sections of chill were uniform except in special cases. Pouring temperatures ranged from 1,260 to 1,320 deg. C., according to an optical pyrometer, the higher pouring temperatures being for the lighter sections. For the die coating, they sprayed on the refractory wash and it was only about four to six thousandths of an inch thick, and was baked on very hard. They then put the die on the machine and gave it a coat of soot once every time round, because they had found out on most parts the soot was scoured in casting, especially on the down gates. A die, when on the machine, might run for a week before being taken off, but when it was then examined, and it might be necessary to recoat it, or it might only be necessary to touch the coating up locally where it had worn.

Shape Limitations

MR. A. DUNLOP asked if there was any limitation in the shape of the casting that could be made. He wondered if there was any trouble with pulls because of the shape, or did the automatic timing eject a casting before shrinkage was set up? On the question of purely refractory moulds, there were moulding materials now available into which could be poured quite a number of castings, the only limitation, again, being contraction.

Ferrous Die Castings Discussion

MR. REDSHAW replied that the process was limited to shape. On a single unit machine, which had been mentioned, where one could get very accurate timing, he thought the process compared very favourably with the non-ferrous casting, as very intricate permanent cores could be used, but on a multiple machine it was not possible to get sufficiently accurate timing, and intricate cores became impracticable.

Inherent Properties

MR. H. G. HALL said the Paper stated that certain physical factors had a more directly observable influence than had chemical variations, and he asked whether that influence was in relation to the founding properties of that iron, or to the annealability.

MR. PAYNE said at the moment they could say definitely that there was a connection between the type of graphite in the pig-iron and the tendency of the graphite in the final structure, and beyond that the subject was conjectural. They had been able to eliminate primary graphite from the final structure by rejecting pig-iron which showed too open a structure or pockets of kish.

MR. A. TIPPER had two practical points to raise with the Authors in drawing a comparison with a similar casting procedure used for production of magnesium castings during the war period. The Authors would agree that it was most important to control the pouring rate into the die; was the orifice of the teapot ladle so designed that the rate of pouring was automatically controlled? He had found that was one way of preventing excessive scrap with hand pouring. The other point was how the Authors cleaned off the refractory coating from the dies. Were they shot-blasted, wire brushed, or were they soaked overnight before cleaning off? This procedure could have a bearing on the life of a cast-iron die.

MR. REDSHAW said the pouring rates of the die were very important, but they did not control it by means of a teapot ladle. It was controlled by the size of the ingate. Regarding the cleaning of the refractory coating, they merely gave a light shot-blasting, using $\frac{1}{32}$-in. dia. ball shot.

Relative Yields

MR. R. C. SHEPHERD asked if the Authors could give their opinion, or any comparison, of the average yields with their process and that which would be obtained with ordinary pattern moulding. It would also be interesting to know what, in the Authors' opinion, would be the minimum number of castings which would be accepted as an order for economical production on their plant.

MR. REDSHAW said the present yield on the plant was 65 to 70 per cent. It varied within 5 per cent., according to the class of work. He did not know how he could give a comparison of that and the sand-cast foundry, because the type of work must be taken into account. If there was a heavy section working, then their yield was outstanding; a yield up to 90 per cent. on heavy castings was possible. A run which made a job a paying proposition was based on a minimum of one die in production one day per week. So long as they were able to fulfil those requirements, then the job was accepted.

Machining Properties

MR. F. E. STEELE said he was interested in the number of castings that were made with this system, and the percentage of castings that had to be machined. He had to make many castings that were small in themselves, the majority of them being without cores, ranging from three-sixteenths to three-eighths of an inch thick. He wondered what success would be achieved by the process under discussion with that type of work when it was realised 98 per cent. of those castings were machined. What was the percentage of castings with this process that were machined?

MR. REDSHAW replied that about 97 per cent. of their castings were machined, the exceptions being merely heavy weights for textile machinery. The Authors' sections for machined castings varied from one-eighth inch up to about four inches, and they were all made from the same iron. As mentioned in the Paper, the machining qualities of the iron were excellent.

Dealing with a previous question from Mr. B. Hird, MR. REDSHAW said there was no stoppage due to their dies getting too hot. This was because the whole machine was continuously air cooled. Pouring temperature was controlled, and the machine ran on non-stop all day long. If dies became too hot, they would be taken off, because something would be going wrong with them. They would be taken off and another die put on, an operation which, incidentally, could be accomplished in five minutes.

Concluding the discussion, the CHAIRMAN (Mr. R. B. Templeton) proposed a very hearty vote of thanks to Mr. Pollard, Mr. Redshaw and Mr. Payne.

B.C.I.R.A. Elects New Members

The following concerns have joined the British Cast Iron Research Association as ordinary members.

The name of the Representative is given between brackets.

Amblecote Foundry, Limited, Stourbridge (Mr. George McMurray, Sr.); Bagshawe & Company, Limited, Dunstable (Mr. R. Gutteridge); J. A. Crabtree & Company, Limited, Walsall (Mr. F. Dodd); Austin Hopkinson & Company, Limited, Audenshaw (Mr. J. Merryweather); Newman, Hender & Company, Limited, Stroud (Mr. N. P. Newman); Serck Radiators, Limited, Birmingham (Mr. C. H. Pattman); L. W. Smith Pty., Limited, Launceston, Tasmania (Mr. L. W. Smith); Textile Machinery Makers, Limited, Oldham (Mr. F. Heywood); Timsons, Limited, Kettering (Mr. E. A. Timson), and Triplex Foundry, Limited, Tipton (Mr. H. E. Hind).

Potclays, Limited, Stoke-on-Trent (Mr. N. Matthews) have been elected as a trade member firm, and Mr. M. M. Misra, of Enfield, and Mr. J. W. Shedden, of Burton-on-Trent, as associates.

Foundry Employment and Production*

Employment in the ironfoundry continues on a very high level, although recruitment of new labour has fallen off considerably. Recruitment of all sections of labour to the ironfoundry between September/December, 1945, was 7,259. During 1946 it was 25,079, and in the first and second quarters of 1947 it was 2,864 and 717, respectively. This makes a total of 35,913 foundry workers recruited and returned to the industry, including ex-servicemen and workers transferred over from steel and non-ferrous foundries. Employment figures for steel and non-ferrous foundries are not available, and it is not possible to say what proportion of recruitment to ironfoundries is at the expense of other sections of the industry. It can be assumed that the proportion is high because of the decline of production in steel and non-ferrous castings, particularly magnesium and aluminium alloys, in the change-over from war to peace production. Except for the intake of apprentices, which is yet far too small, green labour recruitment included in the figures is mainly concerned with so-called unskilled and semi-skilled work and no separate figures can be quoted.

As would be expected, production in ironfoundries shows a very considerable increase in the period 1945-47 as a result of the increased labour force. In 1945 the total production of iron castings, including malleable, was 1,970,000 tons. In 1946 it was 2,537,300 tons and for the first six months of 1947 it is 1,340,510 tons, which is equal to 2,681,000 tons for a full year. A closer scrutiny of the figures shows, however, some less satisfactory features in the light of present needs, as may be better explained from a more detailed examination in the following table:—

	Iron castings produced (tons)	Productivity per year per man employed (tons)
1938 (estimated)	3,300,000	12.5
1945	1,970,900	19.2
1946	2,537,300	19.9

A progressive increase in the productivity of the ironfoundry reaches its highest level in the last quarter of 1946, the final period of the 47-hr. week, which is not fully maintained during the first two quarters of 1947, as is shown in the continuation of the table on a quarterly basis:—

—	Iron castings produced (tons)	Productivity per year per man employed (tons)
1946: 4th quarter 47-hour week ..	709,498	22.2
1947: 1st quarter 44-hour week ..	625,723	19.2
1947: 2nd quarter 44-hour week ..	714,787	21.9

* Extracted from the Journal of the Amalgamated Union of Foundry Workers.

The very considerable decrease in production and in productivity during the first quarter of 1947 is explained by the breakdown of fuel and power. Comparing the second quarter of 1947 with the fourth quarter of 1946, an increase in the total production by an increase in the labour force will be noted, but productivity, *i.e.*, tons produced per year per man, shows a small decrease of about 0.3 tons. This is the price paid in production for the shorter working week during its initial period.

Post-war figures compare very unfavourably with pre-war productivity, but this must be treated with reservations, since not only are actual figures for 1938 not available, but it has also to be kept in mind that with the lightness and intricacy of modern castings, production figures in tons do not reveal the real advance in quantity and value of castings contained in the post-war figures. Allowing for this, and also for the uneven development, *i.e.*, increased productivity in modern mechanised foundries as against a decrease in foundries where equipment has not been renewed or improved, it cannot be gainsaid that over the whole industry productivity has deteriorated. Such deterioration is not explained by the quality of the labour force, although it is certainly true that the proportion of highly skilled craftsmen is declining and there is an unduly high age level due to the fact that over the last thirty years the foundry did not attract the youth, nor was there any provision to give adequate training to the young people who did enter the industry.

Atlas of Defects in Castings

The members of Sub-Committee T.S.9 of the Institute of British Foundrymen are now engaged in preparing Series 2 of the Institute's Atlas of Defects in Castings. To ensure that the best available examples of the various defects which it is desired to illustrate are included in the Atlas, the industry is asked to co-operate in this work by submitting, for the consideration of the Committee, photographs of any of the following:—(1) Sand buckle (grey iron castings); (2) Sand holes (grey iron castings); (3) Shrinkage porosity on machined surface; (4) Crush; (5) Drop; (6) Run-out (complete photograph desired showing what is left of casting together with that metal which has run out on the floor); (7) Veining (marks on dry-sand and loam castings due to mould drying cracks); (8) Gas holes due to chaplets; (9) Imperfect fusion of chaplets; (10) Defects arising from metal inserts; (11) Broken-in risers and runners; (12) Bleeding; (13) Fettling defects (presence of excessive grinding marks); (14) Rat tails, and (15) Blow-holes due to slag inclusions in iron castings.

Examples should be forwarded to the Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3.

MR. C. T. MONSEUR, the well-known Belgian foundry supplies and equipment merchant, has left Liège for a business trip to Canada and the United States.

The National Foundry College

The National Foundry College has now been established and its Board of Governors nominated by the Minister of Education, representing a number of interested bodies in industry and education under the Chairmanship of Mr. Randall G. Hosking. The College will be housed in, and work closely in conjunction with, the Wolverhampton and Staffordshire Technical College.

The Board is charged with the responsibility for providing national facilities for foundry education and research, in the form of full-time courses, vacation courses, refresher courses, and the like, and also for providing regional and local facilities for full-time, part-time day, and evening courses, covering thereby the whole range of foundry education. Their first task will be the re-establishment of the full-time Diploma Course which was the main feature of the predecessor of the College, the British Foundry School, during 1935-39. This Course will normally run for an academic year of 40 weeks from September to July. It is hoped to open the first session on January 5, 1948, to conclude in August. The Prospectus of the College and the curriculum with form of application for admission can be obtained from the Head of the National Foundry College, Technical College, Wulfruna Street, Wolverhampton, to whom applications for admission should be addressed.

The Course will provide the best possible training for those wishing to qualify for positions of highest responsibility in the founding industry and those who are likely to achieve such positions and wish to extend their knowledge to meet the considerable advances made during recent years. It will cover the whole of the foundry industry, ferrous and non-ferrous, including grey, white and chilled iron castings, malleable castings, steel castings, and castings in all non-ferrous metals, such as alloys of copper, tin, zinc, nickel, aluminium and magnesium. The Diploma awarded to successful students will be endorsed by the Ministry of Education.

There is no upper age limit for admission and the standard of practical experience and technical knowledge of candidates must satisfy the Board of Governors that they are in a position to profit from the instruction. A minimum of one year's practical experience in at least one branch of the industry will be required, together with Higher National Certificate, or a university degree, preferably in metallurgy or engineering, or a grade of membership obtained by examination of a professional institution in engineering, metallurgy or chemistry. It is intended to invite nationally-known experts in the industry to participate in the work of the College.

The fee for the Course is £60, payable in advance. At the discretion of the Board of Governors this fee may be remitted wholly or in part for students nominated by firms belonging to trade associations or bodies contributing financially to the College. It is anticipated that many students will be nominated and maintained by their respective firms. It is hoped to provide hostel accommodation for students in due course, but this is unlikely to be ready before the first session is completed.

Further information will be made available shortly with respect to the constitution of the Board of Governors and the bodies represented thereon. The Minister of Education, on the recommendation of the Board of Governors, has appointed Mr. J. Bamford, B.Sc., who was in charge of the British Foundry School during 1935-39, and who has since held important managerial appointments in the industry, to be Head of the National Foundry College.

Meehanite Research Institute

Foremen's and Metallurgists' Conference

The sixth biennial conference of the foremen and metallurgists attached to the British group of Meehanite Licencees' Foundries, took place in Huddersfield on October 8 and 9. The continued popularity of this function was evidenced by the very large number who attended. The whole of the first day was devoted to the presentation of short papers or talks about many aspects of foundry work of particular interest to the foreman or metallurgist. The subjects dealt with included:—The foreman's part in management; mechanisation of foundries; operating aids to production; the use of aluminium moulding boxes; safety and hygiene; and inspection methods.

The morning session of the second day was given over to matters appertaining to moulding and core sand handling, preparation, and testing; sand preparation equipment and its maintenance, and the value of sand control. Discussions were animated with a free interchange of experiences and opinions. During the meeting films were exhibited dealing with safety and hygiene; disposal of cupola slag; and core blowing. The last afternoon was spent at the foundries of J. Blakeborough & Sons, Limited, Brighouse. After a tour of the works the party were entertained to tea, during which Mr. Currie expressed the thanks of the party to the directors of the firm for having granted permission to visit the works and to members of the staff who had acted as guides, a proposal which was received with acclamation. Mr. Ralph Blakeborough, managing director, in responding, said that further extensions and improvements were being carried out, and he hoped that these would be completed in the near future.

Exchange Papers

Mr. R. B. Templeton is to present the British Official Exchange Paper to the International Foundry Congress to be held in Prague next September, whilst Mr. E. Longden, M.I.Mech.E., is to be responsible for the next American Exchange Paper to the American Foundrymen's Association. Both these Papers are to be given on behalf of the Institute of British Foundrymen. Mr. Templeton, who is managing director of Ealing Park Foundry, Limited, and president-elect of the Institute, will deal with some phase of the making of high duty cast iron.

Pig-iron and Steel Production in Great Britain

The following particulars of pig-iron and steel production in Great Britain have been extracted from the Statistical Bulletin for October, 1947, issued by the British Iron and Steel Federation. Table I gives the production of pig-iron and ferro-alloys in September, with the number of furnaces in blast at the end of the month; Table II, production of steel ingots and castings in September, and Table III, deliveries of alloy and non-alloy finished steel. Table IV summarises activities of the steel industry during six months ended September, 1947.

TABLE I.—*Weekly Average Production of Pig-iron and Blast-furnace Ferro-alloys, September,* 1947. (*Thousands of tons.*)

District.	Furnaces in blast, 27.9.47	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants, Essex ..	25	—	12.5	22.4	1.1	—	36.0
Lancs. (excl. N.W. Coast), Denbigh, Flints, and Ches. .. Yorkshire (incl. Sheffield, excl. N.E. Coast) ..	5	—	5.7	—	—	0.6	6.3
Lincolnshire ..	12	—	21.0	—	—	—	21.0
North-East Coast	27	5.4	27.6	0.2	—	1.3	34.5
Scotland	8	0.6	8.2	2.1	—	—	10.9
Staffs., Shrops., Worcs. Warwick S. Wales and Monmouthshire	7	—	5.7	1.3	—	—	7.0
North-West Coast	6	1.7	18.5	—	—	—	20.2
	7	14.1	—	0.1	—	—	14.2
Total ..	97	21.8	99.2	26.1	1.1	1.9	150.1
August, 1947 ..	95	21.6	96.7	25.7	1.1	2.1	147.2
September, 1946	98	19.6	101.2	22.8	1.3	2.4	147.3

TABLE III.—*Weekly Average Deliveries of Non-alloy and Alloy Finished Steels.* (*Thousands of tons.*)

Product.	1946.	1947 (1st 9 months).	1946.	1947.	
			Sept.	Aug.	Sept.
Non-alloy Steel:—					
Heavy rails and sleepers	9.0	7.6	8.0	7.0	7.6
Heavy and medium plates	30.9	30.9	35.2	28.5	35.2
Other heavy steel products	31.9	31.4	35.1	30.5	32.4
Light rolled products (excl. wire rods and alloy steel bars) ..	48.9	48.3	54.3	45.6	51.8
Ferro-concrete bars	3.2	3.0	3.1	3.0	4.3
Cold rolled strip ..	4.2	4.6	4.9	4.5	5.2
Bright steel bars ..	4.5	4.6	5.2	4.3	5.4
Sheets, coated and uncoated ..	22.4	23.8	24.9	19.4	24.2
Tin, terne and blackplate	10.4	11.8	10.9	8.7	12.3
Tubes	14.0	12.7	15.0	12.8	14.1
Wire	11.8	10.6	13.1	9.9	11.3
Tyres, wheels and axles	3.4	3.3	4.2	2.9	3.5
Forgings	4.9	4.7	5.2	5.0	5.5
Castings	2.9	2.9	3.0	3.4	3.2
Total	202.4	200.2	222.1	185.5	216.0
Alloy steel† :					
Plates	0.3	—	0.3	—	—
Tubes and pipes ..	0.2	0.3	0.3	0.3	0.3
Bars, sheets, strip and wire	2.9	3.5	3.2	3.6	3.9
Forgings	1.6	1.6	1.7	1.8	1.9
Castings	0.6	0.6	0.5	0.6	0.6
Total	5.6	6.0	6.0	6.3	6.7
Total production* ..	208.0	206.2	228.1	191.8	222.7
Less Intra-industry conversion ..	16.4	16.3	20.4	14.2	19.7
Total U.K. deliveries	191.6	189.9	207.7	177.6	203.0
Add Deliveries of imported finished steel	—	1.9	—	—	1.8
Total finished steel ..	191.6	191.8	207.7	177.6	204.8

* Includes finished steel made from imported ingots and semi-finished steel.

† Excludes high-speed steel.

TABLE II.—*Weekly Average Production of Steel Ingots and Castings, September,* 1947. (*Thousands of Tons.*)

District.	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants. and Essex ..	—	—	(Basic) 8.9	1.2	0.3	9.9	0.5	10.4
Lancs. (excl. N.W. Coast), Denbigh, Flints, and Ches. .. Yorkshire (excl. N.E. Coast and Sheffield)	1.4	20.2	—	0.5	0.3	21.6	0.8	22.4
Lincolnshire	—	26.0	—	—	0.1	26.0	0.1	26.1
North-East Coast	2.7	47.3	—	0.6	0.4	49.7	1.3	51.0
Scotland	6.5	32.9	—	1.6	0.7	40.1	1.6	41.7
Staffs., Shrops., Worcs. and Warwick	—	12.4	—	0.6	0.8	12.6	1.2	13.8
S Wales and Monmouthshire	9.2	41.7	(Basic) 4.9	0.8	0.1	56.4	0.3	56.7
Sheffield	8.7	19.6	—	6.8	0.6	34.2	1.5	35.7
North-West Coast	0.6	2.9	(Acid) 4.7	—	0.1	8.1	0.2	8.3
Total	29.1	203.0	18.5	12.1	3.4	258.6	7.5	266.1
August, 1947	22.9	179.5	17.9	10.8	3.1	227.5	6.7	234.2
September 1946	22.9	187.4	15.2	9.8	3.2	231.3	7.2	238.5

(Continued on following page.)

Standardisation of Power Plant

Speeding Up Deliveries

The Ministry of Supply has issued an Order which requires the standardisation of heavy electrical plant for the Central Electricity Board's grid system. Its effect will be to shorten the delivery dates of equipment by six to nine months. The new regulation standardises the production of steam-driven turbo-alternators of more than 10,000 kw. at 30,000 kw. and 60,000 kw., which will become the standard plant for large generating stations after 1949.

Mr. G. R. Strauss, the Minister of Supply, explained that the orders for the major items of plant to be installed during this year, 1948, and 1949 had already been placed. For this plant the Ministry's action was limited in the main to ensuring that the manufacturers obtained the materials and labour to keep to production time-tables. It was hoped in 1948 to increase the installed capacity of generating plant by 1,000,000 kw., and during the succeeding years it was hoped that the Order would allow the annual increase to reach 1,500,000 kw., without cutting down the export of heavy electrical equipment.

The Minister said that standardisation of turbo-alternators would not mean uniformity of detailed design. Each manufacturer would continue to use his particular pattern, provided the sets produced conformed to the functional standard specified. This was only a beginning, and the Ministry had found that boilers could be standardised in diameter and thickness; so, too, could steam and water pipes. This would lead to similar measures in other components.

Nobel Prizes for British Scientists

Sir Edward Appleton has been awarded the Nobel prize in physics. He was cited for "his contribution in exploring the ionosphere, the electrically conductive strata in the upper atmosphere of the earth." Sir Edward has been secretary of the Department of Scientific and Industrial Research since 1939. He is particularly well known for his work in the development of radar. Another British scientist, Sir Robert Robinson, who has been president of the Royal Society since 1945, receives the Nobel prize in chemistry.

News in Brief

THE ADDRESS OF the Directorate of Mica is now 23, Buckingham Gate, Westminster, London, S.W.1 (tel.: Victoria 7503).

WILLIAM HAMILTON & COMPANY, LIMITED, Port Glasgow, have received an order for a motor tanker of 13,500 tons from a Norwegian shipowner.

CLAYTON & DAVIE, LIMITED, of Gateshead, are to break up the 831-ton German tramp steamer Hansa, which has arrived in the Tyne from Hamburg.

JOHN JONES & SONS, LIMITED, colliery-plant manufacturers, iron and non-ferrous founders, etc., of Loughborough, recently celebrated the jubilee of the company's incorporation.

MEMBERS of the Executive Council of the Iron and Steel Trades Confederation visited the new physics laboratories of the British Iron and Steel Research Association at Battersea last week, at the invitation of Sir Charles Goodeve, F.R.S., the Director. The party included Mr. J. H. Jones, M.P., Mr. D. O'Sullivan, and Mr. Lincoln Evans, chairman and general secretary of the Confederation.

Recruitment and Training of Shipyard Apprentices

The Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions have reached an agreement to control the recruitment and training of apprentices in the shipbuilding and ship-repairing industry by setting up a National Joint Apprenticeship and Training Committee, and, in districts, Local Joint Apprenticeship and Training Committees. The National and Local Committees are to consist of five representatives from the Employers' Federation and five from the Confederation.

The first duty of the National Committee will be to prepare a scheme covering the whole question of recruitment and training of apprentices for the industry. Later, the Committee will prepare schemes laying down the general basis of training of apprentices for individual classes.

PIG-IRON AND STEEL PRODUCTION IN GREAT BRITAIN (*Continued from previous page.*)

TABLE IV.—*General Summary of Pig-Iron and Steel Industry. (Weekly Averages in Thousands of Tons.)*

Period.	Iron-ore output.	Imported ore consumed.	Output of pig-iron and ferro-alloys.	Scrap used in steel-making.	Steel (incl. alloy).			Steel stocks.*
					Imports.	Output of ingots and castings.	Deliveries of finished steel.	
1938	228.1	89.2	130.0	117.9	16.2	200.0	—	—
1946	234.1	115.4	149.3	147.0	8.3	244.1	191.6	1,223.9
1947—April‡	207.9	122.1	139.2	144.9	9.3	236.4	199.8	915.4
May	213.9	124.0	141.9	149.5	12.3	243.9	197.8	871.3
June	222.7	125.2	144.3	157.6	7.6	254.0	213.2	865.6
July†	209.7	123.6	143.5	128.9	7.5	211.7	183.1	855.2
August	206.8	127.6	147.2	138.7†	5.5	234.2	177.6	815.3†
September	229.2	129.6	150.1	160.7	8.0	266.1	204.8	799.1

* Stocks at the beginning of the years and months shown. † Revised. ‡ Five weeks

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Company News

(Figures for previous year in brackets.)

Ward & Goldstone—Interim dividend of 20% (same).

Concentric Manufacturing Company—Dividend of 25%.

J. Stone & Company—Interim dividend of 10% (same).

Beeston Boiler Company—Interim dividend of 10% (same).

Gerrard Industries—Interim dividend of 10% (same).

Hattersley (Ormskirk)—Interim dividend of 6% (same).

Mellowes & Company—Interim dividend of 10% (same).

Brett's Stamping Company—Final dividend of 20% (10%).

Deritend Stamping Company—Interim dividend of 5% (same).

Lake & Elliot—Final dividend of 15% (16%), making 20% (same).

Irish Wire Products—Final dividend of 7% (6%), making 10% (8%).

E. G. Brown & Company—Final dividend of 10%, making 20% (same).

Tube Investments—Final dividend of 12½% (same), making 25% (22½%).

Dennis Bros.—Final dividend of 216⅔% (116⅔%), making 250% (150%).

Thos. Goldsworthy & Sons—No dividend on the ordinary shares (7%).

Crittall Manufacturing Company—Final dividend of 10%, making 20% (same).

Dunswart Iron & Steel Works—Final dividend of 8% (6%), making 14% (10%).

Associated Equipment Company—Final dividend of 1s. 6d. (2s.), tax free, making 2s. 6d. (same), tax free.

Walmsleys (Bury)—Final dividend of 6% (9%), making 12% for the nine months to June 30 (15% for the year).

Holophane—Net profit to June 30, £34,003 (£25,418); final dividend of 7½%, making 15% (12½%); forward, £23,498 (£20,993).

Dickson & Mann—Net profit for the year ended March 31, £4,019; directors' fees, debenture interest and income tax, £1,901; dividend of 5%; forward, £5,221.

John Shaw & Sons (Wolverhampton)—First and final dividend of 10%, less tax (same) and capital bonus of 5%, not subject to tax, payable out of capital reserve (same).

William Sugg & Company—Net profit for the year ended June 30, £15,782 (£9,441); dividend of 10% (same) and bonus of 15% (5%); forward, £19,550 (£18,884).

S.G.B. (Dudley)—Net loss for the year ended June 30, £11,949 (profit, £15,840), less credit from equalisation of dividend reserve, £4,950; no ordinary dividend (6%); forward, £7,286 (£19,235).

Arundel, Coulthard & Company—Net profit, £23,561 (£8,061); to extra depreciation, £5,000 (nil); to investment depreciation reserve, £5,000; to general reserve, £15,000 (nil); dividend of 2½% (same); forward, £15,817 (£22,068).

George Kent—Net profit for the year ended March 31, after taxation, etc., £4,222 (£30,615); final dividend of 7%, making 10% (same and bonus of 2½%); to employees' assurance scheme, £500 (£2,500); forward, £24,635 (£45,954).

Dowding & Mills—Trading profit for the year to June 30, after depreciation and managing directors' salaries, £24,248 (£17,955); to taxation, £16,100 (£14,500); net profit, £8,148 (£3,455); dividend of 100% (50%); forward, £25,427 (£23,802).

Cornercroft—Trading profit for the year ended June 18, £48,262 (£69,546); to directors' fees, £425 (same); E.P.T., profits tax and income tax, £25,500 (£55,000); general reserve, £7,500 (nil); final dividend of 9%, making 15% (same); forward, £4,718 (£4,333).

Aeroplane & Motor Aluminium Castings—Net profit for the year ended March 31, after depreciation, etc., £18,960 (£19,867); to tax, £9,000 (£13,000); provision for future tax, nil (£4,000); written off goodwill, £5,930 (nil); dividend of 7½% (5%); forward, £30,800 (£30,894).

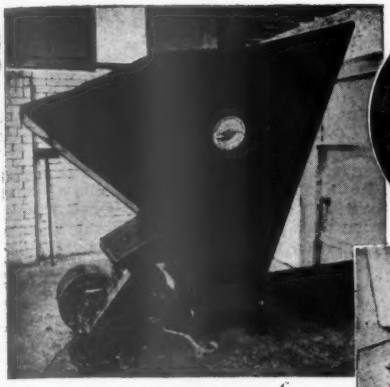
George M. Callender & Company—Net profit for the year ended June 30, after expenses, etc., £8,713 (£3,511); dividend on the participating preference shares of 12% (8%); ordinary dividend of 24.466 per cent. (15%); provision for tax, £795 (nil); general reserve, £4,000 (nil); forward, £2,926 (£1,272).

John Wallace & Sons—Trading profit to March 31, £31,838 (£31,104); to depreciation, £1,185 (£2,490); directors' fees, £1,000 (£500); profits tax and E.P.T., £7,425 (£15,873); income tax, 1947-48, £9,430 (£6,310); total dividends, 17½%, less tax (12½%, of which 2½% was tax free); forward, £33,681 (£24,495).

Henry Berry & Company—Trading profit, after expenses, for the year ended August 31, £18,401 (£8,888); to depreciation, £4,294 (£3,778); directors' fees, £600 (£650); provision for taxation, £4,151 (nil); gratuities to long-service employees, £80 (nil); net profit, £9,282 (£5,678); dividend of 20%, £5,500 (£3,438); forward, £13,273 (£11,471).

Walter Spencer & Company—Trading, etc., profit for the year ended September 30, £31,813 (£12,044); to depreciation, £6,981 (£4,261); written off goodwill, £5,188 (nil); directors' fees, £1,250 (same); E.P.T. and profits tax, £1,500 (refund £7,432); net profit, £16,894 (£13,965); final dividend of 10% (7½%), making 15% (12½%); income tax, £9,000 (£6,500); forward, £5,059 (£5,415).

Tinsley Rolling Mills Company—Profit, after expenses and depreciation, for the year ended June 30, £20,330 (£3,456); E.P.T. recoverable, nil (£3,669); to



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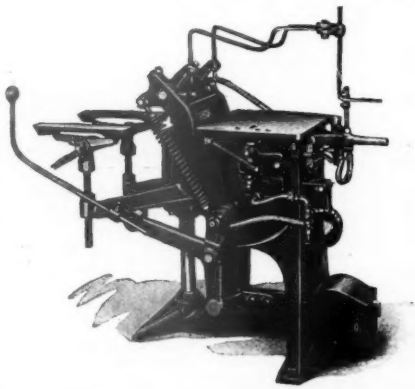

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taxation, £11,000 (£5,835); deferred repairs, £2,000 (nil); general reserve, £5,000 (nil); dividend of 15% (dividend of 7½% and centenary bonus of 2½%); forward, £13,020 (£14,924 after adjustment to include claim of £4,573 net on Iron and Steel Prices Fund).

Pickford, Holland & Company—Trading profit for the year ended June 30, £62,040; other income, £785; depreciation, £8,000; profit, £54,825 (£70,713); to tax, £23,000; general reserve, £7,000; directors' fees, March 1 to June 30, £583; final dividend of 10%, making 17½% (20% on 57,938 £1 shares and 15% on 993 £1 shares); benevolent fund, £500; forward, £27,272 (£20,525). The company was made public in March last.

Smith's Stamping Works (Coventry)—Balance on trading account to August 2, after depreciation, tax, and bringing in £38,000 gross (£94,500); estimated E.P.T. recoverable, £8,777 (£11,948); fees, £13 (£14); dividend from subsidiary, £10,378 (£10,312); interest on tax-reserve certificates, nil (£250); to directors' fees, £900 (£800); net profit. £18,268 (£21,724); dividend of 10% (12½%, including bonus of 2½%); forward, £62,925 (£58,407).

Mountstuart Dry Docks—Profit for the year to March 31, including income from investments, dividends from subsidiary, and after providing for E.P.T. and profits tax, £137,526 (£78,518); to debenture interest, £5,795 (same); directors' fees, £1,131 (£1,129); provision for deferred repairs, £10,000 (£6,000); provision for income tax in respect of current profits, £43,000 (£24,000); general reserve, £45,000 (£15,000); net profit, £32,600 (£26,594); dividends of 8% on the preferred and 10½% on the deferred ordinary shares, less tax, £31,361 (£19,228); forward, £64,027 (£62,787).

John I. Thornycroft & Company—Trading, etc., profit for the year ended July 31, £636,141 (£597,078); to additional deferred repairs, £30,652 (£12,918); benevolent fund, £10,000 (same); depreciation, £110,218 (£94,304); audit, £804 (£721); directors' remuneration, £22,517 (£28,186); income tax, E.P.T. and profits tax, £350,000 (£349,525); net profit, £111,950 (£101,424); to general reserve, £50,000 (same); final ordinary dividend of 10% (same), making 15% (same) and bonus of 7½% (5%); final participating preferred ordinary dividend of 5½% (same), making 9% (same); additional profits tax on interim and final dividends, £4,697 (nil); forward, £102,309 (£101,156).

Frederick Braby & Company—Trading profit for the year ended September 30, £392,506 (£292,322): dividends and interest, £7,602 (£6,589); to debenture interest and deposits, £4,612 (£6,240); directors' fees, £2,100 (same); taxation, £240,000 (£163,000); depreciation, £40,369 (£37,801); net profit, £113,027 (£89,770); to suspense reserve, £65,000 (£50,000); debenture redemption reserve, £7,500 (nil); preference and employees' dividends, £13,720 (£13,510); additional dividend on employees' old stock, £1,440 (same); new stock, £75 (nil); final ordinary dividend of 7½%, making 10% (same) and bonus of 2½% (nil); forward, £64,930 (£64,773).

Parliamentary

State-owned Patents

MR. J. L. WILLIAMS asked the President of the Board of Trade whether he had considered the recommendation of the Committee on the Patents and Designs Acts that all patents in respect of State-owned or State-subsidised inventions should be treated as a public asset and vested in a single central body, capable of estimating the potential value of the inventions concerned and of taking the steps necessary for the development and use of the inventions in industry; and what action he proposed to take.

MR. H. WILSON: Yes. If time permits, I hope to be able to introduce a Bill during this session to set up a body to be called the National Research and Development Corporation which will have essentially the functions recommended by the Patents Committee.

Subsidies to Industry

SIR S. CRIPPS, Chancellor of the Exchequer, asked by MR. OSBORNE what industries were receiving subsidies and how much each received yearly, gave the following list for 1947-48:—Iron and steel, £7,500,000; ferro-chrome, £100,000; magnesium, £250,000; aluminium, £750,000; watch-making and jewel manufacturing, £320,000; cotton spinning, £1,500,000; coal stocking, £350,000; fuel oils and kerosene, £25,000; canals and canal carriers, £810,000; coastal shipping, £710,000; agriculture, £17,981,000; herring industry, £98,000; civil aviation, £7,662,000.

THE MINISTER OF SUPPLY told Mr. G. Roberts that it was proposed to adhere to the plan to import scrap from Germany.

REPLYING TO A question by Mr. McKinlay, the Lord President of the Council said that after consultation with the Secretary of State for Scotland he proposed that the mechanical engineering research establishment should be located in the area of the new town at East Kilbride. Investigations into suitable sites were proceeding. He would do all he could to advance the venture.

Mr. Charles Schneider in London

Mr. Charles Schneider, head of the well-known French concern bearing his name, was the guest of honour at a luncheon in London recently given by Afsa Trading, Limited. Mr. Monfort and Mr. V. Delport had arranged for a representative gathering of the iron and steel industry to meet Mr. Schneider, and in welcoming him reference was made to the negotiations, based on the Marshall Plan, at present in progress between the Schneider group and the Metallurgical Equipment Export Company, Limited, London, for the supply of equipment for rebuilding the Normandie works at Caen in exchange, in due course, for the supply of semi-finished steel to this country.

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Raw Material Markets

Iron and Steel

There continues to be a scarcity of high-phosphorus pig-iron. Every foundry requires additional quantities, but the prospects of receiving extra supplies are not very hopeful. Many foundries are having the utmost difficulty in securing even the restricted quantities which have been licensed, and stocks at both furnaces and foundries are at a very low level. Light foundries could deal with a considerable amount of export trade, due to the contraction in the housing drive, but maximum production cannot be attained because of the shortage of pig-iron and scrap supplies. The scarcity of scrap is causing concern also with the general engineering and jobbing foundries, which require very large supplies both of cast-iron and steel scrap. The shortage is, of course, accentuated by the pig-iron stringency. Fortunately, there is not the same difficulty with the engineering foundries, as they are able to vary the type of iron used. In the main, they require low- and medium-phosphorus pig, and, although supplies of these are not ample, they can purchase hematite and refined pig-iron. These foundries are actively engaged on both export work and the production of castings for the engineering trade. Deliveries of coke generally are coming up to the allocated tonnages and, during the last few months, foundries have acquired considerable stocks of limestone, ganister, etc.

There is no easing of the situation with regard to billet supplies for re-rollers. The recent improvement in the supply from home makers is very welcome, but they cannot possibly achieve outputs large enough to supply all the re-rollers with sufficient tonnage for capacity production. In recent weeks there has been an improvement in the supply of blooms and heavy slabs and the latter have been a considerable help to the makers of wide strip. Makers of the narrower gauges, however, are handicapped through the shortage of light flat billets and squares, and there is an urgent need at present for billets 2 in. to 3 in. for the general rerolling trade. The re-rollers are very heavily booked for months to come, and have large orders on hand for small sections, strip and small bars, while a considerable amount is wanted for P.M.L. priorities. The sheet mills also have full order-books and long waiting periods are necessary for new business. In addition, there is a dearth of sheet bars, so that, in some cases, maximum outputs of sheets are not possible. Steelworks have no difficulty in disposing of defective billets, sheet bars and crops as they arise from current rollings, as re-rollers are glad to accept almost any type of raw material which can be put to good use.

There is no sign of any relaxation of the pressure on the rail and wire mills, while colliery requirements for Period I of next year promise to be heavier than ever. Tube makers are handling an increased volume of export orders and are using correspondingly increased tonnages of strip, etc.

Non-ferrous Metals

Replying to a question in the House of Commons by Mr. Bossom, Mr. J. Freeman (Ministry of Supply) said that the quantity of copper purchased by the Ministry during the period January to October this year was about 230,000 tons. He added that, owing to variation in specifications and, consequently, in quality, an average price would have no significance, but, generally speaking, the prices paid approximated to the New York export price for electro copper, which, during the same period, ranged between £109 7s. and £132 per ton, f.a.s.

Most traders seem to be reconciled to a probable increase in the price of tin, and the only doubt is concerning the actual amount. It is to be hoped that a decision will soon be reached between Bolivia and America regarding the price of tin concentrates to be paid to Bolivia by America during 1948, since this will be one of the chief factors influencing any change in the tin quotation. In addition, of course, uncertainty concerning price levels is not conducive to a steady flow of business.

Although supplies of secondary lead are fairly plentiful, the reverse still applies to the virgin metal. The situation in the United States, however, seems somewhat better and it is probable that during 1948 a reasonable balance between supply and demand will be achieved.

Contracts Open

Any date given is the latest on which tenders will be accepted. The address is that from which forms of tender may be obtained.

Birmingham, December 19—New steam-driven boiler-feed pumps, cast-iron hot well-tank, etc., for the Town Council. Mr. H. J. Manzoni, city engineer and surveyor, Council House, Birmingham. (Fee £2 2s., returnable.)

Clitheroe, December 6—Supply and laying of about 370 yds. of 3-in. spun cast-iron pipes, etc., for the Rural District Council. Mr. A. Brooksbank, 14, The Exchange, Bradford, Yorks.

Manchester, December 6—Steel wheel barrows; street grids, manhole step irons and other castings; bolts, washers, rivets, screws, etc., for the City Council. The City Surveyor's Department (Room 334), Town Hall, Manchester.

Recent Wills

DESOUTTER, L. C., of Bourne End, Bucks, engineer ...	£408,179
MOLINEAUX, J. W., a director of W. G. Allen & Sons (Tipton), Limited, colliery and mechanical engineers, etc.	£16,377
JOLLIE, ANDREW, a director of the United Steel Companies, Limited, Sheffield, and a former chairman of Steel, Peech & Tozer	£90,116
THOMSON, S. R., founder and managing director of Stewart Thomson & Son (Liverpool), Limited, electrical engineers, and a director of the Durable Welding Company, Limited, Liverpool, and Electric Machinery Company (Manchester), Limited ...	£9,236